Pacific Forest Research Centre

Silvicultural Control of Dwarf Mistletoe in Young Lodgepole Pine Stands in Alberta and British Columbia

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Victoria, B.C.
BC-X-180, July, 1978

Environment Canada
Forestry Service

Environnement Canada
Service des Forêts

ABSTRACT

Silvicultural treatments as a method of preventing or reducing the intensification of dwarf mistletoe were evaluated. From 1967 to 1977, 23 plots in young lodgepole pine stands were sanitized by cutting or pruning the infected trees, with retreatment and assessment at 3-year intervals, and subsequent responses by the trees and the disease were recorded. The average percentage of trees infected gradually increased from 45 to 68% (+23%) on the infected, untreated plots, while decreasing from 42 to 37% (-5%) with a thinning and pruning treatment and from 52 to 18% (-34%) when complete eradication was attempted. Comparable changes in average stand infection ratings were +0.62, -0.08 and -0.64, respectively. Despite the three treatments each plot received, mistletoe was not eradicated from any stand. Post-thinning tree mortality, suppression of growth response, and the frequency and intensity of mistletoe increased with age of the treated stand.

RÉSUMÉ

Les auteurs évaluèrent certains traitements sylvicoles pour servir à prévenir ou réduire l'intensification du Faux-gui. De 1967 à 1977, ils nettoyèrent 23 parcelles de jeune Pin lodgepole en coupant ou en élaguant les arbres infectés, avec nouveau traitement et évaluation aux trois ans.. Le pourcentage moyen d'arbres infectés augmenta graduellement de 45 à 68% (+23%) dans les parcelles infectées et non traitées tandis que dans les parcelles à coupe et a élagage, il diminua de 42 à 37% (-5%). Là où on essaya l'éradication complète, il diminua de 52 à 18% (-34%). Le taux moyen d'infection dans les peuplements changea de +0.62, -0.08 et -0.64 respectivement. Malgré les traitements, cette plante nuisible ne fut pas éradiquée d'aucune parcelle. La mortalité des arbres après éclaircie, la suppression de croissance, la fréquence et l'intensité des Faux-guis augmentèrent toutes avec l'âge du peuplement traité.

102-06435/

INTRODUCTION

Dwarf mistletoe (Arceuthobium americanum Nutt. ex Engelm.) is widespread, causing significant loss of vigor, growth, quality and mortality of lodgepole pine (Pinus contorta Dougl. var. latifolia Engelm.) in Alberta and British Columbia. In British Columbia, the area north of Clinton to Prince George, extending west to Anahim Lake, contains the most severely attacked lodgepole pine stands in Western Canada (Baranyay 1972). Large acreages of young lodgepole pine are infected as a result of infected residual trees which were left after fire or harvesting. Silvicultural treatments were considered as a method of preventing or reducing the loss in stand values from the progressive intensification of dwarf mistletoe, but precise information on the effectiveness of silvicultural sanitation procedures was lacking. Accordingly, in 1967, the late J.A. Baranyay initiated a study in Canada comparable to that started in 1965 by F.G. Hawksworth in Colorado (1977), to determine the effectiveness of two thinning methods to control dwarf mistletoe and to record subsequent responses by the trees and the disease.

METHODS

Twenty-three 0.2 ha (0.5 acre) plots were established in fire-origin lodgepole pine stands, 15 in southwestern Alberta and eight in central British Columbia. In 1967, plots were established in 27-year-old stands near Cataract and Etherington creeks, Alberta; in 1968, plots were added in a 22-year-old stand near Dutch Creek, Alberta, and in 35- and 39-year-old stands, respectively, at Beaverdam and Tin Cup lakes, north of Clinton, B.C. Detailed plot location, layout and data recorded initially and during the first re-examination are available (Baranyay 1972). In each area, plots with a surrounding 10-m-wide isolation strip received one of five treatments:

1) Dwarf mistletoe eradication - all visibly infected and all overstory trees were felled, without regard for stocking. Areas still overstocked in 1973-74 were thinned to about 2 m (6 to 8 ft) spacing according to stand age (Fig. 1).

2) Infected thinned - all overstory trees were felled and stands thinned at 2 m spacing. All visibly infected trees were cut, or infected branches of lightly infected trees were pruned, when necessary, to retain adequate stocking.

3) Infected untreated - a check plot.

4) Healthy untreated - a check plot.

5) Healthy thinned - spaced at 2 m, according to age and site conditions.

Plots were laid out and initially treated in 1967 or 1968. Following a second (1970-71) and third (1973-74) treatment, a final examination of the stands occurred in August 1976 or 1977. The untreated check plot at Etherington Creek was inadvertently spaced by the Alberta Forest Service in 1970 and replaced by a new plot established in 1971. Within each plot, two 0.01 ha (0.025 acre) subplots were identified in randomly selected corners and all trees were numbered with aluminum tags for precise recording of tree height, diameter and crown class, and dwarf mistletoe incidence and intensity. The six class system for rating disease intensity (Hawksworth 1977), which was designed for mature trees, was slightly modified for young trees, viz. tree crowns were visually divided into thirds, each third was assigned a value of 1 if one to three branch or stem infections were present and of 2 if four or more infections were present; the values were then summed for each tree and averaged for each subplot.

The number of trees and the percentage infected by dwarf mistletoe were also computed for the entire plot but, since the trees were not tagged and considerable ingrowth occurred, less precise comparisons could be made than for the subplots. During the final inspection, increment cores from standing trees or disks cut at breast height from trees felled during the last sanitation treatment were collected and annual increments were measured to determine growth response to the various treatments.

A

B

C

Figure 1. Dwarf mistletoe infected lodgepole pine stand near Dutch Creek. A. Before treatment in 1968. B. After all visibly infected saplings and 29 overstory residuals were eradicated in the first of three sanitation treatments. C. In 1976, 32% of the remaining trees were infected but only one exceeded infection class one.

RESULTS

Incidence of Infection

The initial incidence and intensity of infection within a stand and even within plots varied considerably, but both were generally highest in the older stands at Beaverdam and Tin Cup lakes. The amount of infection also increased with the number of infected overstory trees. The average number of infected residual overstory trees per infected plot was 18 (std. dev. 15), with a maximum of 50 in the eradication plot at Beaverdam Lake. Location of infection within a stand was largely determined by the distribution of infected residual trees in the plot or the adjacent isolation strip.

The percentage of trees infected and the average stand infection ratings for each treatment are summarized in Figures 2 and 3, respectively. At plot establishment, the incidence of mistletoe in the infected treated plots ranged from 15 to 60%. The average percentage of trees infected gradually increased from 45 to 68% (+23%) on the infected untreated subplots in the 9-year interval, while decreasing from 42 to 37% (-5%) with thinning and pruning, and from 52 to 18% (-34%) with attempted eradication. The average stand infection rating increased from 0.8 to 1.4 in the infected check plots, an increase of 0.62, compared to a decrease of

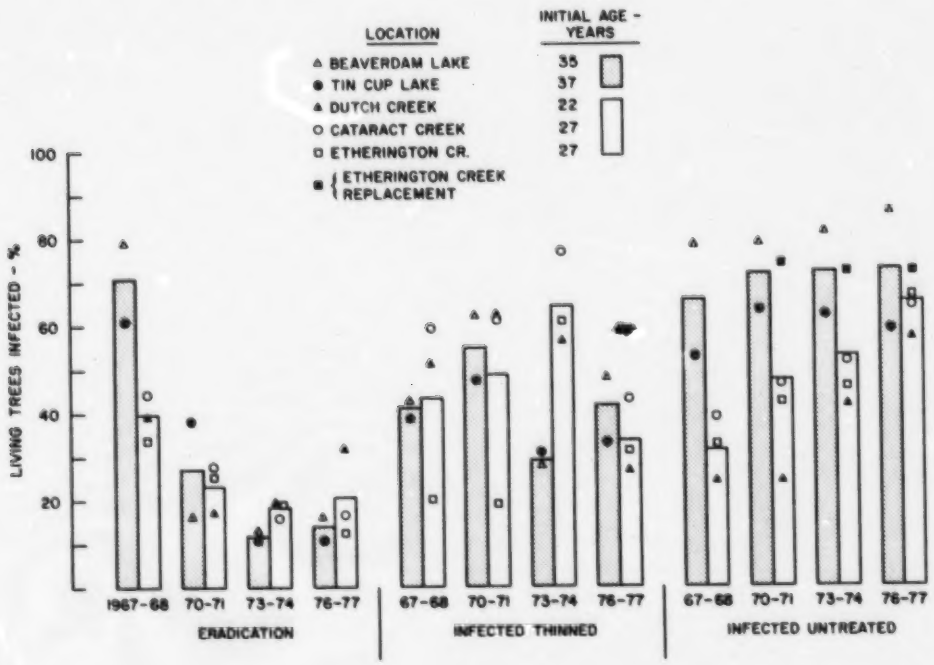

Figure 2. Average per cent of living lodgepole pine trees infected by dwarf mistletoe in two subplots in each of five stands with sanitation treatments at 3-year intervals. Three stands were initially less than 30 years old and two were older.

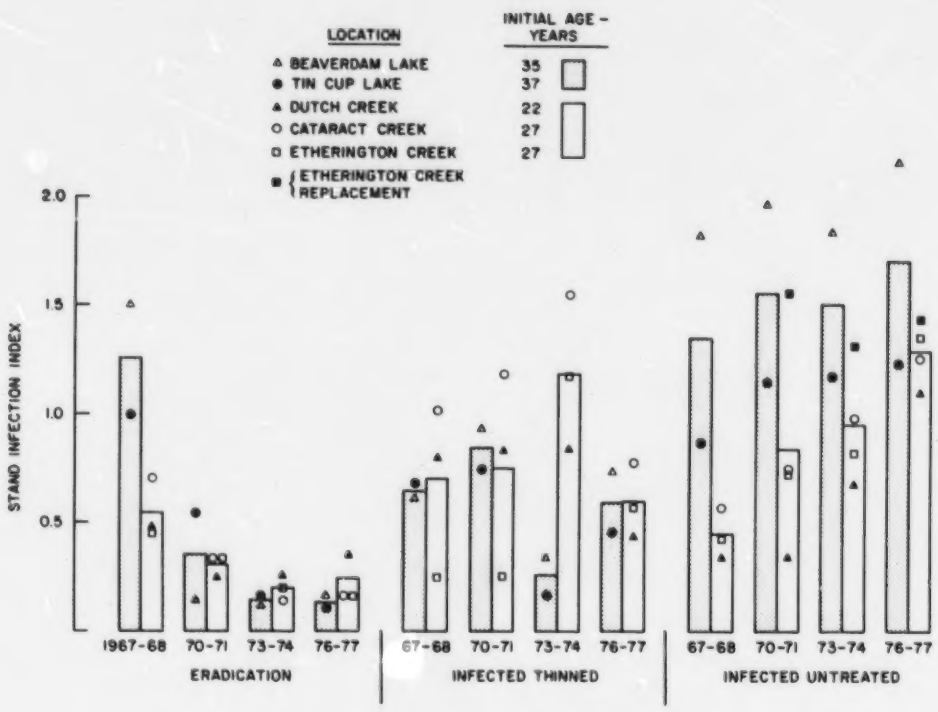

Figure 3. Average dwarf mistletoe stand infection index for three lodgepole pine stands less than, and two stands more than 30 years old with sanitation treatments at 3-year intervals.

0.64 in the mistletoe eradication plots and 0.08 in the thinned and pruned plots. However, despite the three treatments each plot received, mistletoe was not eradicated from any stand. The thinning and pruning treatment took longer and required more careful inspection of infected trees, but it was not as effective as the eradication treatment in reducing the incidence and intensity of dwarf mistletoe. Although not eliminated, mistletoe incidence and intensity was appreciably reduced by the eradication treatment. On average, the amount of infection 3 years after the first sanitation cut was about half the initial level and about half again at the third examination. In four stands, the level of infection at the fourth and last inspection had reached that present prior to the third sanitation, but in the youngest stand (Dutch Creek), it had increased almost to the initial level (Figs. 2 and 3).

In the infected check plots, the average mistletoe incidence increased about 3% a year in stands less than 30 years old, and about 1% a year in older stands. Average stand infection ratings in the 9-year interval increased 0.7 in the younger stands and 0.35 in the older stands. Self-pruning of lower branches in dense stands, and occasionally rodent chewing, removed infections or infected branches; however, in most cases, new infections in the upper crown or in previously healthy trees were more numerous and the net effect was still an in-

creased incidence and intensity of disease. In the eight healthy plots, only five mistletoe infections were found from 1967 to 1977, and all were in the healthy-thinned plot at Beaverdam Lake. Apparently the amount of infection originating beyond the stands was limited during the study.

At Etherington Creek, an area including the infected untreated plot was mistakenly thinned by a crew unaware of the presence of the disease. Because infected trees were not systematically cut and many healthy trees were removed, the percentage of infected trees almost doubled in the interval 1967 to 1970, increasing from 19 to 36%, compared to a decrease of 1 and 14% in the nearby infected thinned and eradication plots. Stand infection ratings in the subplots increased by almost one class from 0.4 to 1.36, compared to an increase of 0.33 in the infected thinned plot and a decrease of 0.31 of a class in the eradication plot.

Tree mortality and growing stock

Lodgepole pine infected stands did not respond well to release after a prolonged period of suppression and a high proportion of the uninfected released trees died after treatment, causing further reductions in stocking. In the younger stands, less than 30 years old initially, mortality in the 9-year interval averaged 11% (range 1-21%) in treated stands, compared to 1.6% in the healthy thinned stands and 2.6 and 4.6 in healthy untreated and infected untreated plots (Table 1). In the two older stands, 34% of the leave trees died in treated plots.

Changes in average tree diameter, height and numbers per acre during the study are summarized in Table 2. The average per plot increase in diameter of the leave trees in young stands exceeded those of the older stands by 13 to 21%. The eradication treatment caused the greatest initial reduction on tree

Table 1. Percentage of released lodgepole pine trees that died following various stand treatments to reduce dwarf mistletoe infection

Location	Stand Age in 1967-68 (years)	Treatment				
		Infected			Healthy	
		Eradication	Thinned	Untreated	Thinned	Untreated
Dutch Creek	22	1	16	1	0	1
Cataract Creek	27	21	9	5	0	2
Etherington Creek	27	10	11	8	5	5
Average	25	10.6	12.0	4.6	1.6	2.6
Beaverdam Lake	35	61	15	31	12	37
Tin Cup Lake	37	55	7	26	–	–
Average	36	58.0	11.0	28.5	12.0	37.0

Table 2. Average diameter, height and stocking of five lodgepole pine stands at three periods during dwarf mistletoe sanitation treatments, based on two subplots per treatment in each stand

Stand characteristic	Infected			Healthy	
	Eradication	Thinned	Untreated	Thinned	Untreated
D.B.H. (cm):					
– Initially	3.15	3.61	3.38	5.00	4.36
– After initial treatment	2.69	4.10	–	6.73	–
– At last inspection	3.66	5.74	4.85	8.89	4.99
% change	+16.2	+59.4	+43.5	+77.8	+34.6
Height (m):					
– Initially	3.08	3.86	3.12	4.55	4.38
– After initial treatment	2.81	4.21	–	5.61	–
– At last inspection	3.00	4.93	3.97	6.87	5.92
% change	–2.6	+27.7	+25.6	+51.0	+35.2
Stems/hectare:					
– Initially	18 630	16 310	13 290	19 770	23 870
– After initial treatment	9 740	2 470	–	2 130	–
– At last inspection	2 320	1 730	9 190	2 080	22 590
% change	–87.5	–89.4	–30.8	–89.5	–5.4

diameter and height. This treatment was most destructive in the older stands at Tin Cup and Beaverdam lakes where, because of severe, patchy infection, some areas were almost clearcut for the treatment. Since disease incidence in the dominant crown class averaged 63% (range 17 to 100%), compared to 45 to 50% for the suppressed intermediate and codominant classes, removal of infected trees greatly decreased the stand height and diameter.

Growth rates

Comparison of the average annual ring widths for the 8- or 9-year periods before and after treatment in three stands showed a 3 to 13% increase in growth rate in trees in infected treated plots, and 25 to 29% decreases in the untreated infected and healthy plots. However, within each treatment, the relationships were not consistent for all stands (Fig. 4). Conse-

quently, firm conclusions should not be made without studies to quantify the effect of treatment, stocking, stand age, site and dwarf mistletoe on merchantable wood production.

DISCUSSION

Mistletoe was not eradicated despite the three sanitation treatments provided at 3-year intervals. Although an effort was made to detect and remove every infection or infected tree at each examination and all overstory trees were cut during the first treatment, 11 to 49% of the trees remaining in the plots had one or more infections when last examined. Many of the infections found during the first re-examination could have been latent when the plots were established; but as time passed, this proportion should have declined. Apparently numerous infections were missed during each treatment despite the relatively thorough examination by trained personnel. However, increased light and wider spacing may also have contributed to the increased infection in treated stands. Stand opening provides ideal light conditions for increased dwarf mistletoe seed production (Baranyay 1962). Spacing crop trees so

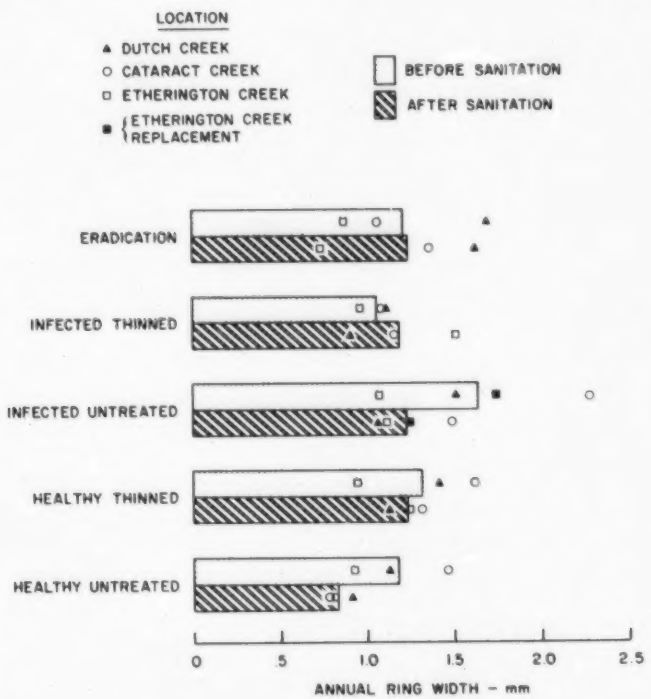

Figure 4. Average annual lodgepole pine ring width at breast height during the 8- or 9-year period before and after the initial sanitation treatments at three locations; based on one radius in each of at least three trees per treatment.

that crowns are 6 m (20 ft) apart largely prevents mistletoe spread between these trees (Knutson 1975) but, with closer spacing, seed dispersal may be enhanced (Hawksworth 1958; Hawksworth and Graham 1963).

In a similar study in northern Colorado, latent and missed infections also prevented elimination of the mistletoe, and treatment generally reduced the percentage of infected trees to about half the amount removed in the initial sanitation (Hawksworth et al. 1977). They found degree of infection, not strictly stand age, to be the best guide for successful treatment; generally, removal of all infected trees was not recommended in stands with more than 40% of the trees infected. However, tree growth response after treatment was apparently not examined. To prevent severe understocking such as occurred in some of the older Beaverdam and Tin Cup plots, they now recommend thinning young stands to specific growing stock levels, and leaving lightly infected trees, if necessary, to obtain the desired spacing.

Although mistletoe was not eliminated from treated stands and the percentage of trees infected at the last examination ranged from 11 to 49, none exceeded a class three rating. With the attempted eradication, 13% of the trees in the five locations rated infection class one, 0.4% rated two and 0.7% rated three. Comparable values for the infected thinned treatment were 21, 11 and 4%. In the untreated plots, 59% were in classes one - three and 7% were greater. Long-term records on disease intensification are required; however, applying a constant, average disease increase comparable to the infected untreated plots, the eradication plots could reach the three stand infection index level at which growth losses are felt to be significant in about 40 years. This is a 20-year retardation over comparable untreated plots and perhaps close enough to rotation age that subsequent losses will not be major. With the higher levels of infection, the infected thinned stands would have to be retreated about 10 years earlier to maintain an average stand infection index below three.

RECOMMENDATIONS

The inability to eliminate dwarf mistletoe from young lodgepole pine stands, even with three successive treatments, emphasizes the importance of control efforts during stand harvest and second crop establishment which more effectively minimize the infection in future stands.

If, in future, the level of forest management in B.C. does support silvicultural treatment of the vast backlog of dwarf mistletoe infected lodgepole pine stands, efforts should be concentrated on the youngest stands. As stand age increases, mortality and suppressed growth rates, as well as the frequency and intensity of mistletoe, increase. Stands should not be immediately cut to crop tree levels for fear that significant understocking could result with any subsequent mortality. Ignoring, or failing to recognize, a mistletoe problem in a stand during spacing or thinning could easily intensify the disease and minimize returns from the effort.

Long-term observations on the rates of disease intensification compared to the growth rates and eventual merchantability of infected stands are required to critically evaluate silvicultural treatments.

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BC-X-180, July 1978.